NASA Electronic Parts and Packaging (NEPP) Program

NEPP Program Task 16-294
Gross Leak Standard Development

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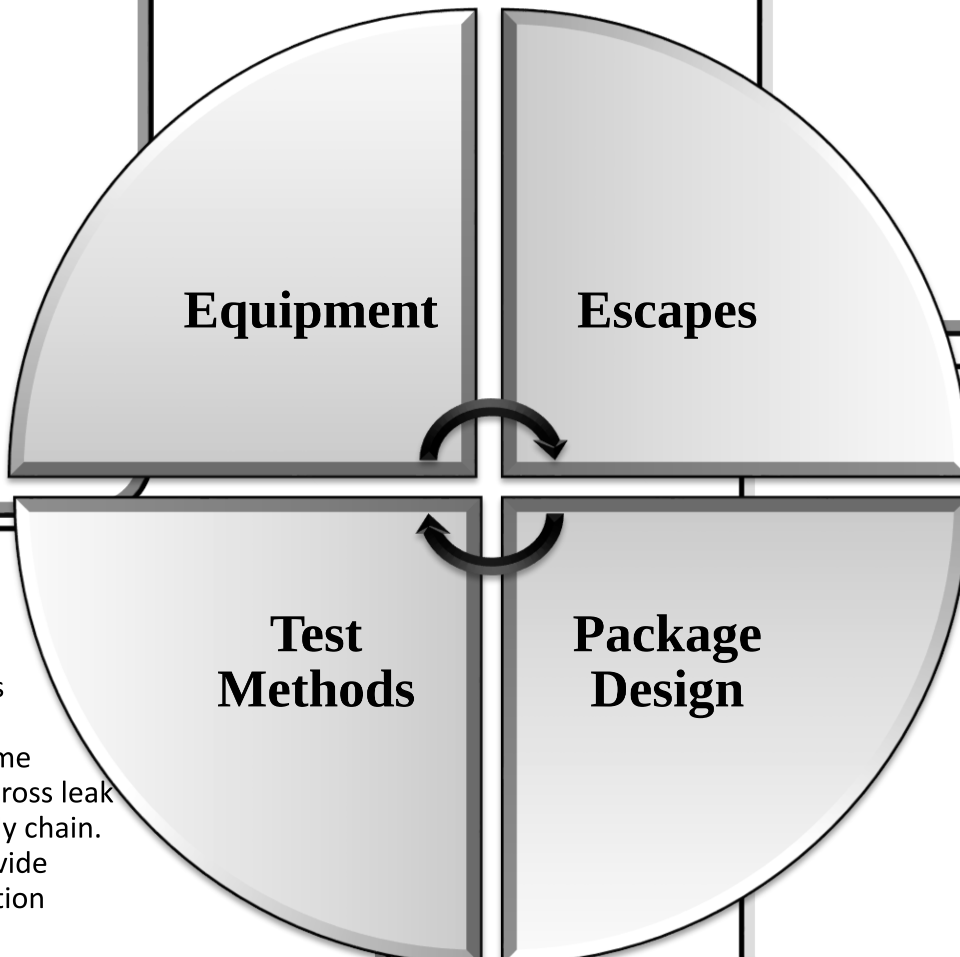
Gross Leak Standard Development

Purpose

- There are several types of hermetic test equipment on the market. All of the available equipment has pros and cons to testing. These standards were developed to conduct round robin studies on a level playing field to understand how each piece of equipment detects gross leakers as well as verify that the equipment setup is capable to detect a gross leaking device.

- Small volume devices in particular have inherent detection issues such as reduced internal volume capacity and some are further hindered by package design construction. The gross leak standards volumes being developed span the small volume range.



- Current test method procedures require optimization to ensure equipment setup for small volume devices is sufficient to prevent gross leak escapes from entering the supply chain. This development work will provide solid data to aid in the optimization process.

- EEE part construction materials varying heights of internal components can result in test interferences and erroneous results. Some of these issues are not fully documented or well understood. A one size fits all equipment setup without verifying actual parts being tested exacerbates the issues. These standards will provide a means to verify equipment setup.

Package Design

TO-5
0.064 cc

TO-46
0.039 cc

TO-18
0.025 cc

Gross Leak Standard Development Plan

Phase 1: Design

- Adsorption Free Construction Materials
- Fabricated Using Typical Manufacturing Processes
- Micron Sized Holes (? - ? µm)

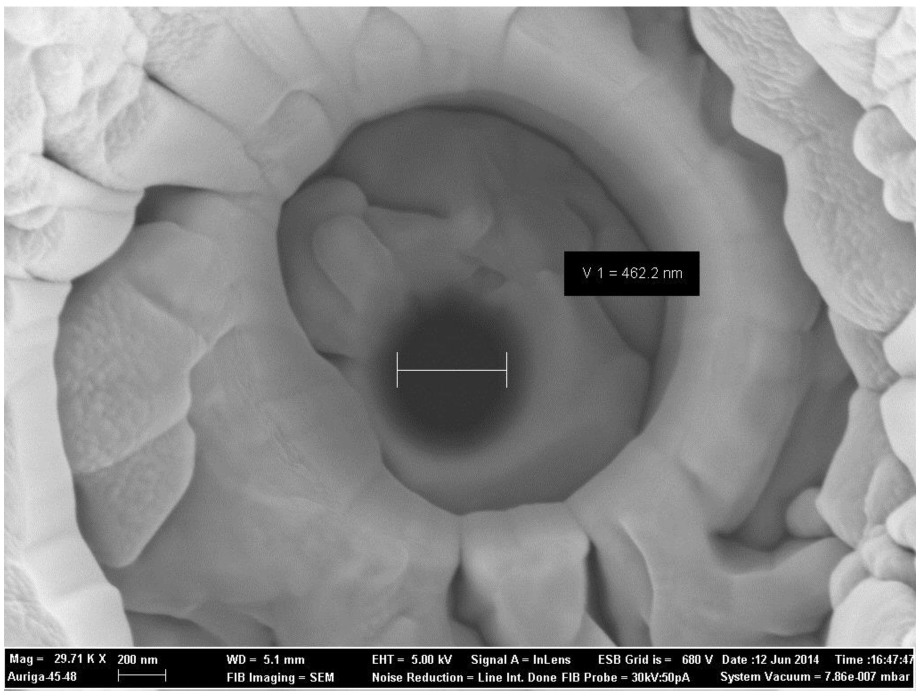
Phase 2: Validation

- Round Robin Measurements with Hermetic Test Equipment
- Identification of Strengths & Weaknessses
- Design Review: Go/No Go Decision

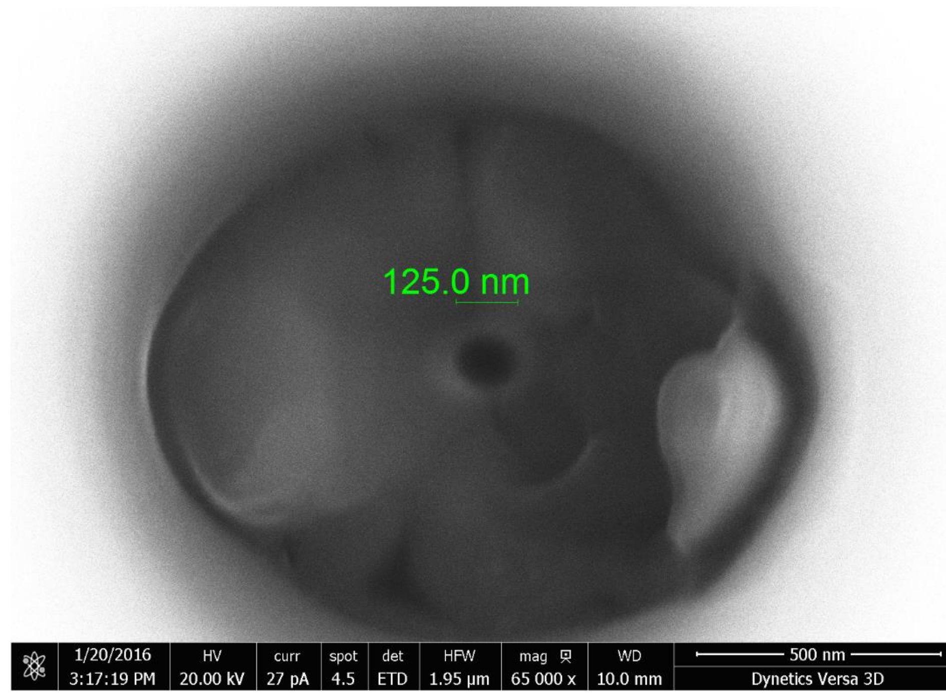
Phase 3: Implementation

- MIL-STD Optimization Based on Validation
- NIST and/or ANSI Standardization

- **Images of Focus Ion Beam Milled Gross Leak Standard Prototypes**
  - *In an initial feasibility study, Zeiss was able to mill a 462nm diameter hole in a TO-5 style prototype sample. They felt an even smaller hole could theoretically be achieved using FIB milling. Their efforts paved the way for further study.*
  - *Dynetics optimized the Zeiss micro-machining process and was able to achieve a 125nm diameter hole in a TO-46 style prototype sample. The sample shown below in the 65,000x SEM image was detected as a gross leaker using Kr85 hermetic test equipment in a 2 hour long timed study. Additional testing is being performed.*

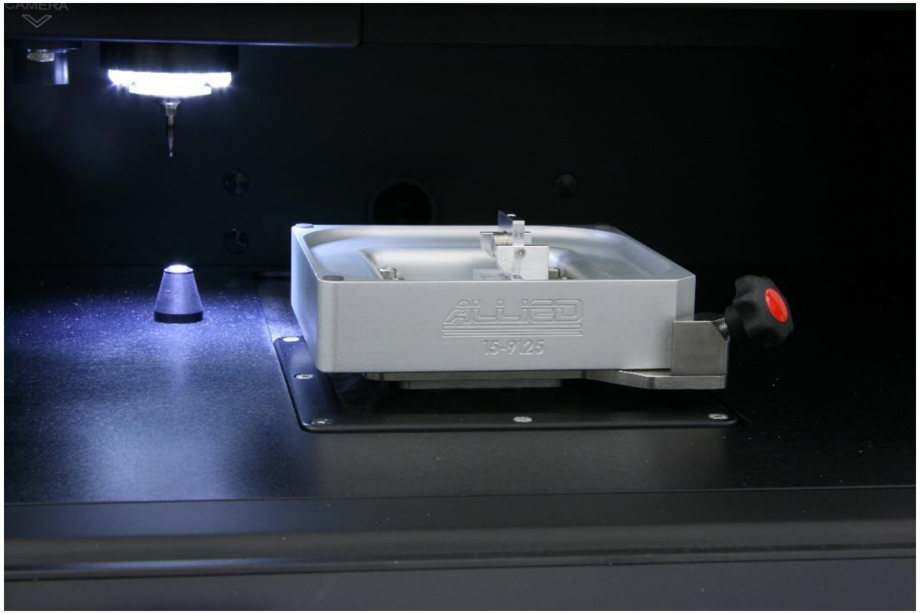


Zeiss Sample

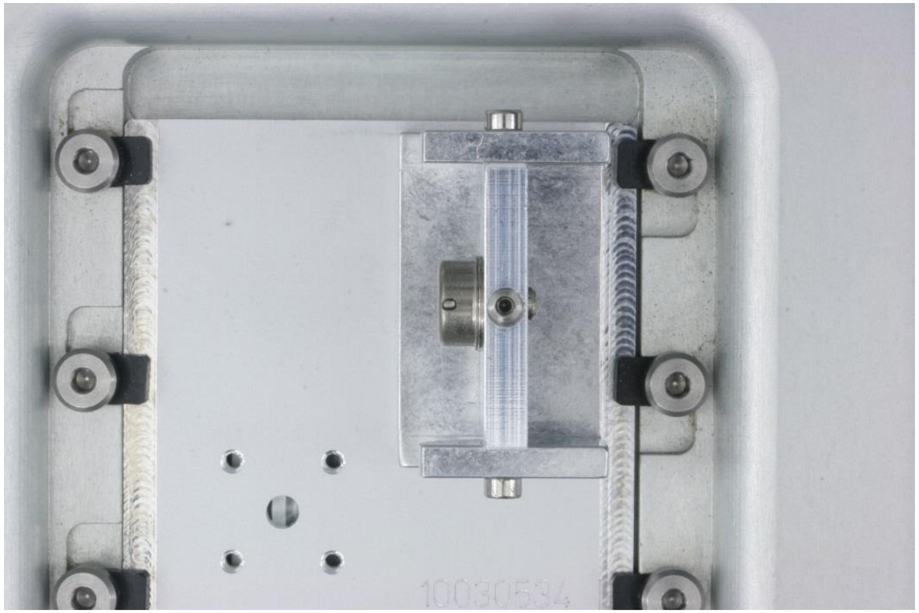


Dynetics Sample

- **Dynetics Mechanical Milling Process** (TO-46 Standard: *SN B016)*
  - *Standard samples were first mounted in a specialized fixture and mechanically milled to pre-thin side wall to approx. 60um thickness prior to Focus Ion Beam (FIB) milling.*



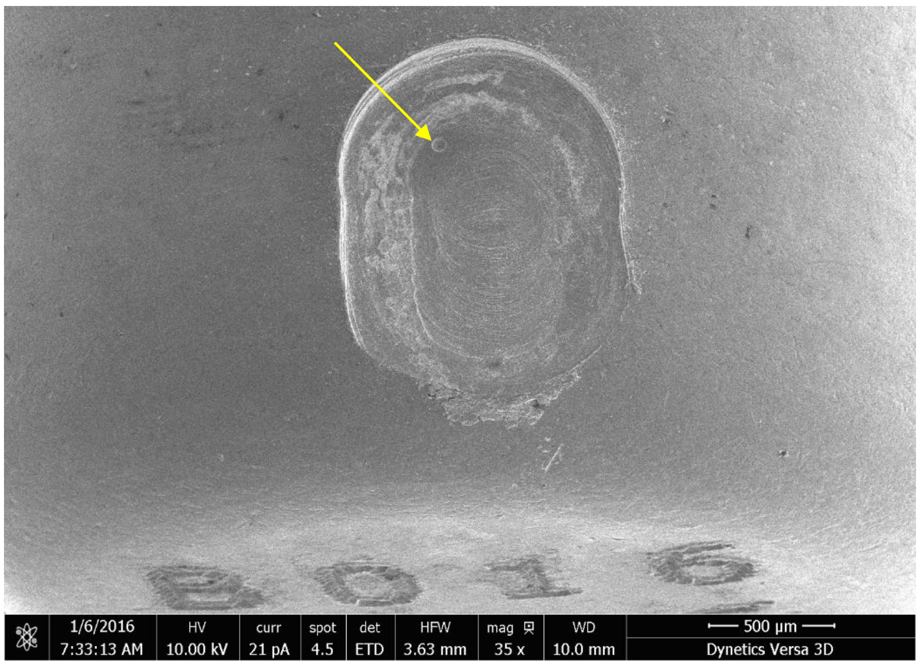
Mounting Fixture



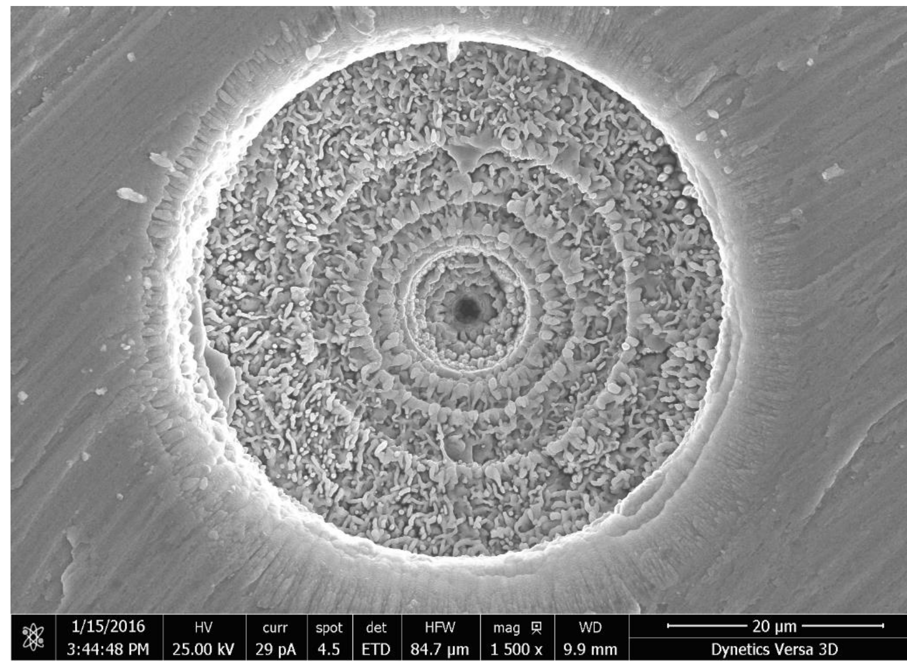
Milled Hole

Gross Leak Standard Development

- **Dynetics FIB Millig Process** (TO-46 Standard: *SN B016)*
  - *The FIB hole milling was performed in the most pristine area of the machined drill site. The yellow arrow in the 35x SEM image below identifies the actual FIB milled hole.*
  - *The second SEM image taken at 1500x shows the step by step milling process.*



FIB Hole Placement



FIB Milled 125 nm Hole

Future Work

Optimize Process

- Mill 125nm holes in the other two standards (TO-5, TO-18).
- Perform round robin testing with all hermetic test equipment to establish a baseline and confirm equipment test capability.

Apply Technique

- Mill 125nm holes in commercially available parts.
- Perform round robin testing with all hermetic test equipment to confirm equipment test capability and validate instrument setup procedures used in product qualification.

Document Procedure

- Propose inclusion of this technique in the military standard hermetic seal test method documents as a process monitor to mitigate the occurrence of gross leak escapes. *(MIL-STD-750 TM1071 and MIL-STD-883 TM1014)*
- Pursue NIST/ANSI standardization.

Questions?

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